SUBSTITUTE SPECIFICATION

DEVICE FOR CLEANING POLLUTED AIR BREATHED IN BY LIVING ORGANISMS

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an air cleaning device for air drawn from a polluted space into a closed space, especially for cleaning air breathed in by a living organism.

2. Discussion of Background Information

[0002] It is known that gas was first used in military action in the first world war so as to obstruct military actions of the enemy, and the so called gas-masks were developed as a means of defending against it. These devices were manufactured with parameters that had to comply with the most stringent standards even in the present days. At first, the gas-masks comprised a disguise-like mask covering the face with air-tight sealing, and were provided with an air filter in front of the nose and the mouth placed in a usually cylindrical house, and the air cleaned by the filter could get to the respiratory organs only through this filter.

[0003] Due to the development of technology, the quality of the gases applied changed, and the filters were designed according to the new challenges in order that the efficiency of filtering and the lifetime of the filter should meet the specified minimum requirements. However, this resulted in such an increase in the weight of the filter that using the uncomfortable gas-masks became nearly intolerable.

[0004] This problem was to be eliminated by a construction where the filter was mounted to another part of the body and the cleaned air was conducted to the mouth opening of the mask through a flexible goose neck.

[0005] As the development of the quality of filters could not keep up with the quality requirements of the filters, these constructions could meet the above mentioned requirements only by increasing the mass of the filters. A further problem arose in that the quality requirements became more and more stringent. It was found that the gases to be filtered contain pollution in the form of dust in a very wide range. The diameter of the dust particles getting into the filter range between 20 mm and 0.001 mm. Radioactive decay products are of molecular size, and metallic decay products act like gas pollution. In spite of this fact, these decay products are referred to as dust. However, the filters applied in the present day gas-masks are only able to filter out dust particles with a diameter exceeding 0.3 mm. It is known that dust particles of this size are the most harmful for living organisms. The cells in the alveoli of the lung enclose these dust particles and they can not be removed from the organism by the usual cleaning methods.

[0006] It is a common feature of the filters in the gas-masks that the air flows by the aspiration of the living organism, and therefore their resultant air resistance must not exceed a certain maximum value that would make the breathing of the living organism significantly harder.

[0007] It is also known that in the electrostatic dust separators, the medium carried by the gas flow is charged up by electric charges. This charged medium, in turn, flows through an electric field, where it is separated. It is an advantage of this method that the majority of organisms, bacteria and viruses carried by the polluted air are also destroyed. Therefore, it is also suitable for biological defense. It is a disadvantage that usually their space demand is significant.

[0008] There are also known dust separators where the polluted air flows swirling in a downwards narrowing space and the particles touching the boundary wall of circular cross section lose their angular momentum and fall down to the bottom of the space. These are the so called cyclone dust separators. However, the space demands of these devices

increase with the required increase in the rate of rotation, and they are able to separate only a small fraction of the floating particles.

[0009] It was the purpose of the construction presented in Hungarian patent specification HU 193 944 to eliminate this drawback, which construction combined the electrostatic and cyclone dust separators and the advantages thereof, and made it possible to construct dust separators of smaller volume. The spinning motion is generated by wing-shaped electrodes (which are plume shaped in cross section). The polluted air is introduced in a tube coaxial with the cylindrical housing and the air gets inside the housing through the air holes on the curved surface of the tube. The alternately positively and negatively charged air channelling electrodes of circular configuration generate an asymmetric force field and increase the rotation of the air through nearly the entire length of the housing. The scattering electrodes are situated between the air channelling electrodes and they are of the opposite potential than the nearest air channelling electrodes, and are also arranged in a circular configuration. This construction allowed a significant reduction in size and therefore it was suitable for cleaning diesel soot as well. However, it was a disadvantage of this construction that due to the small distance between the wing-shaped air-channelling electrodes and the scattering electrodes there was an increased risk of spark-over, while if the applied voltage was reduced, the ionisation current was not sufficient.

[0010] A further development is presented in Hungarian patent specification HU P 01 04988, where there is a hollow electrode of drop-shaped cross section. The polluted air flows through the electrode and let out through a slit formed along the entire length of the hollow electrode, cutting the edge passing through the cusp of the drop-shaped cross section. Furthermore, the scattering electrode is positioned at the outlet edge of the convex outside wall of the hollow electrode. Therefore, due to the high exit speed of the air, the ions are concentrated at the scattering electrode, and the ions are removed from the vicinity of the outlet edge, and so the required ionization current can be achieved even at lower voltages.

[0011] This construction reduces the space demand significantly, especially if applied with a rough pre-filter and with a traditional paper filter and/or gas filter at its output, while it is capable of filtering out even the smallest particles. Though it is the smallest one of the electrostatic air cleaning devices of similar capacity, it is still too large for being used as an individual filter in a gas-mask, even if in individual filters there is no need for a ventilating fan carrying the polluted air.

SUMMARY OF THE INVENTION

[0012] According to the invention, an electrostatic air filter is created, which keeps the quality of the known electrostatic air filters while it is suitable for being connected directly or at least indirectly to traditional gas-mask filters and to increase the working life of the air filter, while neither its weight nor its air resistance is so big as to obstruct the user in its actions.

[0013] The fundamental idea of the invention is that if the electrodes are positioned inside a conducting cylinder and the temperature of the electrodes is increased above the temperature of the environment using extra-low voltage, the ionization current can be increased with orders of magnitude without generating electric spark-over between the electrodes. This result is obtained as a combined effect of quasi-thermic heating and field emission.

[0014] According to the invention, the electrode system generating the electric field is situated inside supporting tubes made of electrically conducting material that can be connected to 0 potential. Furthermore, the entire curved surface of the supporting tubes or at least their portion close to the front surface is covered with screen of low air resistance allowing diffuse flow, while the space in the housing between the supporting tubes is filled with filter insert medium.

[0015] The scattering electrodes of the presently known electrostatic filters operate on the basis of field emission effect, while the electron tubes operate on the basis of

thermoemission. There is no device operating on the basis of thermoemission at atmospheric pressure. With individual air filters, the user of the filter aspirates the air at significantly lower speed than with collective filters where the speed of the injected air depends on the air carrying capacity of the ventilating fan. With individual filters, the mechanical stress on the electrode wires is significantly lower, and this fact makes it possible to place the electrode wires in the air flow. Due to the low speed of air, the required heating power is lower.

[0016] A device for cleaning polluted air in a closed space, the air being breathed in by living organisms, according to one aspect of the invention, comprises an axially symmetric housing having an insulating disc with openings for introducing polluted air on one side thereof which is orthogonal to an axis of the housing situated at an atmospheric side, a perforated insulating front surface on a user side of the housing, orthogonal to the axis opposite to the insulating disc, supporting tubes situated parallel to the axis acting as a boundary for the air flow, and an electrode system generating an electric field. The system includes positively and negatively charged scattering electrode wires situated inside the supporting tubes and, made of electrically conducting material that can be connected to 0 potential. The supporting tubes have curved surfaces wherein at least a portion of the closed surfaces close to a front surface is covered with a screen of low air resistance allowing flow diffusion, a filter medium insert being provided in a space in the housing between the supporting tubes.

[0017] According to other aspects of the invention, the supporting tubes may be secured to the insulating disc on the atmospheric side. The disc may include circular grooves for receiving the supporting tubes. The device may further include an electrode holder made of plastic, arranged coaxially with and inside each of the supporting tubes. The electrode holder may be cylindrical.

[0018] According to further aspects of the invention, there may be an even number of scattering electrode wires arranged in circular symmetric configuration on a curved surface

of the electrode holders and parallel to the axis of the electrode holder. Adjacent electrode wires may be oppositely charged. An electronic power supply may be situated on an axis of the housing insulated in an air-tight fashion from the other parts of the housing by an inside bordering wall and the scattering electrode wires may be connected to the electronic power supply after crossing the insulating disc.

[0019] According to yet further aspects of the invention, the supporting tubes may be closed air-tight at their end at the front surface on the user side by a separate front disc connected to the front surface. At the end of the supporting tube, at the front surface on the user side, the supporting tubes may be closed air-tight by being directly connected to the front surface. The ends of the electrode holders on the user side may be connected to a front disc attached to the front surface. Alternatively, the ends of the electrode holders on the user side may be connected directly to the front surface.

[0020] According to another aspect of the invention, a device for cleaning polluted air in a closed space, the air being breathed in by living organisms, comprises an axially symmetric housing having an insulating disc with openings for introducing polluted air on one side thereof which is orthogonal to an axis of the housing situated at an atmospheric side, a perforated insulating front surface on a user side of the housing, orthogonal to the axis opposite to the insulating disc, and supporting tubes secured to the insulating disc on the atmospheric side and situated parallel to the axis acting as a boundary for the air flow, the supporting tubes being received in circular grooves formed in the insulating disc. An electrode system generates an electric field, the system including positively and negatively charged scattering electrode wires situated inside the supporting tubes and, made of electrically conducting material that can be connected to 0 potential. The supporting tubes have curved surfaces wherein at least a portion of the closed surfaces close to a front surface is covered with a screen of low air resistance allowing flow diffusion. An electrode holder made of plastic, is arranged coaxially with and inside each of the supporting tubes, there being an even number of scattering electrode wires arranged in circular symmetric configuration on a curved surface of the electrode holders and parallel to the axis of the

electrode holder. A filter medium insert is provided in a space in the housing between the supporting tubes.

[0021] According to yet another aspect of the invention, a device for cleaning polluted air in a closed space, the air being breathed in by living organisms, comprises an axially symmetric housing having an insulating disc with openings for introducing polluted air on one side thereof which is orthogonal to an axis of the housing situated at an atmospheric side, a perforated insulating front surface on a user side of the housing, orthogonal to the axis opposite to the insulating disc, and supporting tubes secured to the insulating disc on the atmospheric side and situated parallel to the axis acting as a boundary for the air flow, the supporting tubes being received in circular grooves formed in the insulating disc. An electrode system generates an electric field, the system including positively and negatively charged scattering electrode wires situated inside the supporting tubes and, made of electrically conducting material that can be connected to 0 potential. The supporting tubes have curved surfaces wherein at least a portion of the closed surfaces close to a front surface is covered with a screen of low air resistance allowing flow diffusion. A cylindrical electrode holder made of plastic, is arranged coaxially with and inside each of the supporting tubes. A filter medium insert is provided in a space in the housing between the supporting tubes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The invention is described in more detail with reference to the embodiments shown in the drawings, where

- Figure 1 shows an axial section of an embodiment of the air filter device; ,
- Figure 2 shows section A-A of the air filter device shown in figure 1;

Figure 3 is a partial axial section similar to Figure 1 but showing a second structural configuration of the air filter device; and

Figure 4 is an axial section, similar to Figure 1, showing a second embodiment of the invention.

[0023] The air filter device shown in Figure 1 has a cylindrical housing 6 bordered by a closed (non air-permeable) curved surface 1, a front wall 3 on the atmospheric side provided with openings 2 for aspirating the incoming polluted air, apart from which openings the front wall 3 is closed, and a front surface 5 on the user side provided with perforations 4 for letting through the outgoing air, apart from which perforations the front surface 5 is closed.

[0024] In the housing, in axial symmetric configuration, there are supporting tubes 8 with their axes parallel to the axis of the housing 6, with perforated walls preferably made of plastic, with their curved surfaces coated with preferably, a woven conducting screen 7. The plastic wall and/or the screen 7 is made of conducting material that can be connected to 0 potential. The supporting tubes 8 are fixed to the insulating disc 9 situated parallel to the front wall 3 on the atmospheric side, and are preferably fitted into the circular grooves 18 (see Figure 3) formed on the insulating disc 9. There are openings 10 on the insulating disc 9 for introducing the polluted air coming through the openings 2 into the inner part of the supporting tubes 8. Inside the supporting tubes 8 there are electrode holders 11, preferably cylindrical electrode holders 11 made of plastic, arranged coaxially with the supporting tubes 8. There are an even-number of scattering electrode wires 12 arranged in circular symmetric configuration on the curved surface of the electrode holders 11, parallel to the axis of the electrode holder 11. Every two scattering electrode wires 12 situated opposite to each other are connected to each other somewhere near the end of the electrode holder 11 close to the front surface 5 at the user side. According to the example, the electrode holder 11 is directed through the insulating disc 9. The scattering electrode wires 12 are connected to the electronic power supply 14 after crossing the insulating disc 9, which power supply 14 is situated in the axis of the house 6 insulated preferably air-tight from the other parts of the house 6 by the inside bordering wall 13. The surface of the screen 7 can be made electrically conductive, e.g., by vacuum spraying.

[0025] At their end at the front surface on the user side, the supporting tubes 8 are closed air-tight by a separate front disc 15, as shown in Figure 1, or by being connected directly to the front surface 5, as shown in Figure 4. The electrode holders 11 are also connected to the front disc 15 or to the front surface 5 (Figure 4) so as to stabilize their position.

[0026] The parts of the housing 6 outside the supporting tubes 8 and the bordering wall 13 are filled with the filter insert medium 16. perforations 4 on the front surface 5 on the user side are situated on the surface of the front surface 5 adjoining the filter insert medium 16. On the curved surface 1, close to the front surface 5, there is a quick connection mechanism for establishing connection to the input of traditional gas-mask filter inserts, e.g. a spring type clamp joint mechanism 17 or a bayonet catch.

[0027] The air cleaning device according to the invention operates as described below. The polluted air gets through the openings 2 of the front wall 3, then through the holes 10 of the insulating disc 9 into the inner part of the supporting tube 8 constituting the "active zone". The scattering electrode wires 12 are connected to the extra-low voltage outputs of the electronic power supply 14 in the space between the front wall 3 and the insulating disc 9 in a way that the charge of the adjacent electrode wires 12 are opposite to each other. As the first step of chemical reactions in the active zone controlled redox processes take place, this is effective in the range of molecular size pollutants as well, resulting in approximately 1:5 rate decrease in the concentration.

[0028] In the active zone, the component of the ion velocity orthogonal to the axis is significantly higher than the average axial velocity of the air to be cleaned As a result, the double layer on the surface of bacteria is broken, the plasma of the bacteria is damaged and the living organism dies.

[0029] The air partly cleaned this way gets into the filter insert medium 16 through the screen 7 and the supporting tube 8. In the meantime, the dust particles in the air coagulate and the maximum of the dust distribution curve moves up by about one order of magnitude

from the biologically most harmful zone, which significantly increases the filtering time of the dust filter paper in traditional gas filter inserts, so the so called breakdown time is increased. If the breakdown time is increased by a factor of 1:10, it means that the user of the gas mask can use the gas filter for 20 hours instead of the presently typically permitted 2 hours, thus being able to spend ten times more time in the polluted area than until now.

[0030] In case of radioactive dust, the pollution particles of larger diameter getting into the lungs can be discharged by the natural cleaning mechanisms and the radiation exposure is reduced significantly. This way, the most harmful components can be prevented from closing the pores of the alveoli in the lungs.